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ON RESPONSIVE ENVIRONMENTS.

BY- MOORE, OMAR KHAYYAM
PITTSBURGH UNIV., PA., LEARNING RES. AND DEV. CTR.

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EDUCATIONAL TECHNOLOGY IS OF GREAT IMPORTANCE NOW BECAUSE THE ENORMOUS INCREASE IN THE RATE OF TECHNOLOGICAL CHANGE WHICH TOOK PLACE DURING THE 1940'S HAS ALTERED OUR SOCIETY FROM A PERFORMANCE TO A LEARNING SOCIETY. IN A PERFORMANCE SOCIETY, LEARNING IS A PRELUDE TO THE PRACTICE OF A FIXED SET OF SKILLS. HOWEVER, IN A LEARNING SOCIETY THE REQUIRED SKILLS CHANGE TOO RAPIDLY FOR THIS TO BE POSSIBLE. LEARNING MUST CONTINUE INTO ADULTHOOD, AND MAKING THIS POSSIBLE REQUIRES A THOROUGHGOING REFORM OF EDUCATIONAL INSTITUTIONS. THESE MUST NOW INCULCATE FUNDAMENTAL CONCEPTS AND ABSTRACT SYMBOLIC SKILLS RATHER THAN TECHNICAL VIRTUOSITY. THROUGH THE USE OF COMPUTERS AS TEACHING MACHINES, TECHNOLOGY CAN BE TURNED BACK ON ITSELF TO SOLVE THE PROBLEMS IT POSES. THIS USAGE IS NOW BEGINNING TO BE REALIZED THROUGH THE INTERVENTION OF "BIG BUSINESS" AND GOVERNMENT. ONE EXAMPLE OF THIS USAGE IS THE DEVELOPMENT OF THE EDISON RESPONSIVE ENVIRONMENT MACHINE OR "TALKING TYPEWRITER." HERETOFORE, THE BEHAVIORAL SCIENCES HAVE NOT CONTRIBUTED TO EDUCATIONAL TECHNOLOGY, BUT THIS MACHINE IS BASED ON A SOCIOLOGICAL CONCEPTUALIZATION OF THE LEARNER AND HIS ENVIRONMENT. THIS HAS LED TO STARTLING RESULTS. IT ALSO HAS OFFERED A POSSIBLE SOLUTION TO THE PROBLEM OF MATCHING HARDWARE AND SOFTWARE AVAILABILITIES BY USING THE LEARNER AS A SOURCE OF MATERIAL FOR HIS OWN EDUCATION. SOME EXAMPLES OF THE CAPABILITIES OF LEARNERS, IN THIS CASE CHILDREN FROM 3 TO 6 YEARS OF AGE, ARE ILLUSTRATED BY 5 FILM CLIPS (REFERRED TO AND DESCRIBED BUT NOT INCLUDED IN THE DOCUMENT). THIS PAPER WAS PRESENTED AT THE ABINGTON CONFERENCE '67, "NEW DIRECTIONS IN INDIVIDUALIZED LEARNING," APRIL 23-27, 1967. (DR)

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OMAR K. MOORE

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ON RESPONSIVE ENVIRONMENTS

Omar Khayyam Moore

Learning Research and Development Center

University of Pittsburgh

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ON RESPONSIVE ENVIRONMENTS

Omar Khayyam Moore

Those of us who are especially concerned with educational technology have worked out a more or less standard way of introducing this topic. We generally begin by discussing changes in the rate of technological change. The main points are as follows:

(1) In the 1940's the major industrial societies of the world underwent a massive acceleration in technological development. This increase in the rate of technological change was so large, as far as its social consequences are concerned, as to amount to a difference in kind rather than one of degree. Because of this, many observers have come to divide technological history into two main periods--the primitive, from the dawn of human history to the 1940's, and the modern, from the 1940's on. In order to make this case we draw graphs of technological functions. For example, we plot, on a time scale of 10,000 years, the speed of travel, the force of explosives, the size of objects which can be manipulated with precision, the number of people that can be included simultaneously within one communcation network. The curves for most technological functions bend sharply upward at about this time--and now they have gone off the graph.

There are some who are unhappy with the notion of pin pointing this acceleration in the decade of the 1940's. They prefer to think in terms of a series of accelerations, each jolt larger than its predecessor. The time span for this series is taken to be the first half of the 20th century. In either case, almost everyone who has considered the matter carefully agrees that there has been a radical change in the rate of change and that we are now living in a new era.

(2) As a result of this technological acceleration, we are in transition from what I have termed a "performance" society to a "learning" society. In a performance society, it is reasonable to assume that one will practice in adulthood the skills which were acquired as a youth. Some of our linguistic conventions make clear what I have in mind. We think of a medical student as learning medicine and the mature doctor as <u>practicing</u> it. There is also the <u>practice</u> of law, and, in general, adults have been <u>practicioners</u> of the skills which they learned as apprentices.

In contrast, in a learning society it is not reasonable to assume that one will practice in adulthood the skills which were acquired as a youth. Instead, we can reasonably expect to have several distinct careers within the course of one lifetime. Or if we stay within one occupational specialty, it can be taken for granted that it will be fundamentally transformed several times. In a learning society, education is a continuing process--learning must go on and on and on. Anyone who either stops, or is somehow prevented from learning, is reduced, thereby, to the status of an impotent bystander.

One of the unfortunate consequences of living in a learning society is that there is little opportunity to polish any given skill before it is necessary to change again. This has led to a dangerous kind of sloppiness which pervades all too much of our lives. For instance, it is not reassuring to reflect on the possibility that the pilot of the jet on which we may find ourselves, might respond, in an emergency, to the control panel configuration of last year's model. And this emergency, in turn, might have been caused by the improper assembly of a K3871B improvement.

My jaundiced view of some technological improvements stems from the fact that, on occasion, I have had to beg engineers to stop improving a piece of equipment so that there was at least some possibility of its working without a resident engineer in attendance--and so that the machine operators would have a chance to learn their job.

(3) Another consequence of the shift from a performance to a learning society is the need for a thoroughgoing reform of our educational institutions--their administration, their curricula, and their methods of instruction. It is clear that education must give priority to the acquisition of a flexible set of highly abstract conceptual tools. An appropriate theoretical apparatus would range not only over the physical and biological sciences, but over the subject matter of the behavioral and social sciences as well. What is required is the inculcation of a deep conceptual grasp of fundamental matters--mere technical virtuosity within a fixed frame of reference is not only insufficient, but it can be a positive barrier to growth. Only symbolic skills of the highest abstractness and greatest generality are of utility in coping with change. In my opinion, some of the current reforms in the

mathematics curriculum are in the right direction. In a few schools, instruction in mathematics now begins with topics with which graduate education once ended. Some children now are being introduced to mathematical ideas in a set-theoretical way rather than through drill within the context of, say, the decimal system. These youngsters are exposed to alternative systems, for example, binary or octal arithmetic, and they are encouraged to explore other systems on their own so as to engender an abstract appreciation of mathematical notions--and hence they may avoid the danger of becoming prisoners of one system.

(4) The next standard move in explaining how to handle the problems which arise in societies undergoing massive acceleration is to point out that the same technology, which is proving so difficult to control and to live with, can be turned back upon itself, as it were, to help out the educational process. Computers used in conjunction with automated equipment can be used as teaching machines and learning machines. For instance, the learner can sit before a control panel and explore the structure of equations by manipulating the values of their variables--the feedback to the learner can take the forms of visual and auditory displays, and kinesthetic and tactile stimulation. He can be an active agent in the learning process through the use of a technology which makes it possible for him to be patient to the consequences of his own symbolic acts. In brief, the sophisticated technology which we are evolving can be converted into a responsive environment--an environment which is sensitive to individual differences among learners; an environment which is compatible with the expression of the learner's own creativity; an environment which allows the learner to make nontrivial discoveries.

(5) Ten years ago, the notion of using sophisticated technology as an essential part of education was an abstract possibility. Today this possibility is in the process of being realized--both big business and big government have defined educational technology as big business. I would not want to suggest to you that this is an unmixed blessing, but as things stand now, in the United States at least, unless major American corporations are willing to put millions and millions of dollars into this venture, and unless the federal government cooperates in providing funds for development and

demonstrations, this technology will not come into being. As I remarked, this is happening and there is every reason to believe that the rate of expenditure on advanced educational technology will accelerate so rapidly that within five to ten years this will be a major industry in its own right. The question as to whether efforts along these lines is another instance of "too little too late" is hotly debated. In any case, ten years ago neither business nor government was involved in any substantial way. Now they are.

(6) Let us turn our attention now to educational technology itself. The first point I would like to make is that from its beginnings in the 50's to the present, the behavioral sciences, with the exception of experimental psychology, have played a minor role. The complex equipment which is now on the market, and most of that which is on the drawing boards, are due primarily to engineers, aided occasionally, by consultants from the field of psychology. Sociology has played almost no part in this development. An exception, of course, is my own work which is, naturally enough, fundamentally sociological in character. The machine which Richard Kobler, an engineer, and I invented, the Edison Responsive Environment, or E.R.E., popularly known as "the talking typewriter", is best thought of as a Meadean machine (Meadean in the sense of George Herbert Mead). When I say it is Meadean, I wish to call attention to the fact that it was designed explicitly to function as a part of an environment in which the learner begins by engaging in a "conversation of gestures" and moves on to the internalization of "significant symbols." It is part of an environment in which the learner can take the perspective of an agent, the Meadean "I," the perspective of a patient, the Meadean "me," a reciprocal perspective, the Meadean "significant other," and finally the referee's perspective, the Meadean "generalized other."

Further, I define an environment as symbolically stimulating if it permits the participant to assume these various perspectives, one by one, in pairs, in triples, and hopefully, in one superordinate quadruple. As with Mead, language is taken to be of central importance in the socialization process. Reading and writing are treated as visual analogues of speaking and listening. Every effort is made to relate these four linguistic processes to each other in such a way that the learner can draw upon them one by one, in pairs, in triples, and again hopefully, in one superordinate quadruple.

By taking this sociological stance, not only toward the design of educational technology, but also toward its employment, my colleagues and I have been able to achieve results which have startled the world of education. I do not maintain that a sociological approach is the only one which would be sufficient to generate the phenomena which we witness in the laboratory. However, up to the present time, I have not seen similar results produced in other ways. To the best of my knowledge, no straightforward psychological program of research has treated the learner in a laboratory as an element in a complex interactional process. Most psychologists with whom I'm acquainted tend to confine their attention to the interrelation between the learner and the instructional device. They do not make explicit provision, conceptually that is, for treating this relation as part of a broader social process. As a consequence, they find it difficult to replicate our results. When, however, a sociologist, especially one who understands the Symbolic Interactionist position, comes to one of our laboratories, he sees at once the rationale of our equipment and methods. He does not lose his way by searching endlessly for the specific reinforcements which allegedly must sustain the learner's on-going behavior.

The main point I would like to make here is that I fear that researchers, and the general public as well, are likely to be disappointed by the new educational technology if it is used in a way which presupposes that the relation between learner and machine is all there is to it.

In my opinion, what is wanted is an overall analysis of the structure of the laboratory environment--of course including the machine--taken as a social organization with its own social processes. Explicit attention also must be given to the relation between the laboratory environment and the world outside of it.

(7) Next, let me suggest how taking a sociological perspective with regard to the development of educational technology has helped us avoid one of the current problems which plagues engineers and others who proceed without such a view point. The problem to which I refer has to do with the relation between "hardware" and "software". At any given moment there seems to be either too much hardware or too much software and the two seldom get

together. Let me illustrate. If a team of engineers at Electronics Corporation X, the producers of Brand X, plan an instructional system with 30 consoles backed up by a general purpose computer with provision for time sharing, this group of engineers no sooner begins the task of sketching out machine functions, when someone, probably from management, comes along and says, "Where are you going to get the programs to feed this monster? Perhaps we ought to buy a publishing company and shred its books as a starter. Or perhaps we ought to hire a small army of educators and psychologists to write programs for it. Or perhaps we ought to buy one of the small companies which specializes in programed instruction."

Looking at the matter from the standpoint of the buyee who has software, its research team is likely to bemoan the fact that their hardware capabilities do not extend much beyond mechanical page turners. Of course, the optimists in both the hardware and software camps look forward to the day when the two capabilities are joined.

It has been my experience that neither the engineers nor the experts in programed instruction are likely to seek a solution in the forgotten man, the subject, known more commonly as S. In our research, we proceed on the assumption that most of the content which ultimately ends up in the computer can be obtained from the learner himself. For instance, we do not have an official word list, or an official story series for our children--we use the child's own vocabulary as a point of departure, his own interests as guides to the selection of story material. A skeptic might concede that this is a feasible modus operandi for teaching children to read and write, but that it would be inappropriate if applied to mathematics or many other technical subjects. I would reply that the learner is again being underestimated and ignored. Let us take mathematics as a case in point.

I admit that it is going to be much more difficult to use the learner in a creative way in devising instructional systems in mathematics, but it is not impossible in principle. It would require that programing begin by taking account of the formal structure of the social processes in which the learner is implicated. Currently, of course, there are no adequate mathematical analyses of these processes. For example, we would have to have formal

analyses of the logic of questions and answers (erotetic logic), the logic of social norms (deontic logic) and so forth. These and other mathematical specialities are being created now, partly because of our requirements. We must be in a position to characterize the formal aspects of the learner's own social environment. This, I submit, would be an appropriate starting point for his mathematical instruction; he would have an intuitive grasp of the relations involved and they are bound to be meaningful to him.

One of the reasons that the development of a theoretically sophisticated way of conceptualizing social environments is so necessary is that without it, it will be extremely difficult to carry out the educational reforms referred to above. To put the matter another way, the relatively primitive nature of sociology, social psychology and psychology is a major handicap in producing a satisfactory educational technology. Such progress as has been achieved in our project is due largely to the insights we have managed to derive from some of the seminale thinkers in these disciplines. It seems to me that we are unlikely to make any substantial breakthroughs without further theoretical clarification. And, of course, what we and others are learning about human nature, about social processes, and about social structure is certainly relevant to a thoroughgoing theoretical reconstruction of these fields. The upshot is that the forthcoming marriage between hardware and software is much more likely to go on the rocks than many educational technologists think. And in the meantime, the most reliable guides to successful programing and to successful machine design are the learners themselves--they should be taken seriously.

(8) Since we have been speaking of subjects, or better, learners, it is perhaps time to have a look at some of the children who have helped clarify for us the nature of human capabilities. You will see five film clips. Taken together they will give you an overview of the evolution of our educational technology.

We begin with scenes taken at one of our laboratories in Hamden, Connecticut, which shows nonautomated equipment. Clip #1 begins with 4-year-old Jimmy who is working out the pronunciation of words. Then you will see a 7-year-old veteran of our program who is a speedy, competent typist. There

is a scene of a 7-year-old reading Alice in Wonderland. Finally, there is 4-year-old Freddy who makes clear why it is important to be flexible--Freddy is mainly interested in his own name.

(film shown 5'6")

Clip #2. Here you will see one of the most extraordinary performances that we have been able to generate--a three-year-old girl takes her own dictation. In the first part of this clip, you will see her read a story--she has a microphone in her right hand. As she reads, she puts in whatever punctuation she thinks she will need when she takes this same material in dictation. Her first words along these lines are "new paragraph capital Zeke...." In the second part of this clip, the viewer is turned off and she listens to and types what she has previously read. In order to take dictation at the age of three, she must have learned to read, to type, to handle the controls of the dictation equipment--which you will notice are located near the space bar on the typewriter. She must also be able to spell and have some sense of punctuation. She must also be able to speak clearly enough to understand herself. This child is shown handling some 60 controls. I think that this performance is something of a world record for 3-year-olds.

(2'33")

Clip #3. In this third clip you will see a 4-year-old working with a prototype of our present automation. It is a crude device, but the child uses it effectively. For a bit, this little girl types along without difficulty. Suddenly, she hits a snag--she has forgotten where the lower-case key is. She calmly works out a search pattern for locating the "lost" key, finds it and goes on her way. All the while she is looking for it the machine keeps reminding her of what she is looking for. It does not lose its patience and neither does she.

(2'45")

Clip #4. Clip 4 was made this June at the request of Illinois' Cook County Department of Public Aid. Our Hamden, Connecticut, training cadre is teaching Cook County employees how to operate a Responsive Environments laboratory. This is part of a $2 1/2 million contract from the Office of

Economic Opportunity (OEO). We are also working with the New York City public school system and the State Teachers College in Greeley, Colorado, under this same OEO project. There is to be a 20-machine laboratory in New York City, a 10-machine laboratory in Chicago, and a nonautomated laboratory in Greeley, Colorado.

The first part of this clip shows children coming to the Responsive Environments Laboratory in Hamden, Conn., followed by several scenes of Cook County employees being greeted by our staff. Then the camera goes indoors to shoot a scene of the latest model of the talking typewriter. A 5-year-old is using it. Notice that it not only talks but that it also has dictation capabilities. If you look carefully you will see a moving red line on the lower right side of the machine which indicates to the child how long he has to talk--before the machine stops "listening."

Finally, in this clip, there is a brief scene showing one of our laboratory supervisors explaining to a Cook County trainee some of the functions of the control panel.

(7'2")

Clip #5. The fifth and final film clip is, in many ways, like the clip of dictation. The children are doing something very difficult. You will see four children, two of whom are senior editors of the laboratory newspaper. They have edited the first-grade newspaper and next year they will be the editors of the second-grade newspaper. They have selected two children, a 6-year-old girl and a 5-year-old boy who are now kindergartners, to be the editors of next year's first-grade newspaper.

I asked the two senior editors to meet with the editors-to-be and to explain to them the nature of an editor's task. At first, they were reluctant to do this on the grounds that the new editors were too young to understand, but they agreed to try anyway. All four children know that they are being photographed and they are quite self-conscious about it. In the first part of this clip the senior editors each reads one of his own pieces to the trainees. One piece is about the death of President Kennedy, the other is a very subtle piece about a child's invisible friends. This child's invisible friends

are numbers. Several fairly deep issues come up in the course of the editors' conference. One issue is how far can you go in correcting someone's work without turning it into your own composition. Another issue is what to do if none of the contributions are much good? The part of this clip which I like best comes up when the tiny 5-year-old, after listening to all the duties of an editor says "You can't be an editor if you get tired, can you," to which a senior editor replies, "If you are going to be an editor, editors don't get tired."

(8'1")

I hope that you have enjoyed these film clips. I hope also that I conveyed some sense of the intellectual challenge which the development of a satisfactory system of educational technology entails. I have tried to make clear that sociology has a contribution to make to this field, and that if sociology takes a more active role, this is likely to have beneficial effects on the development of the discipline itself.